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STATISTICAL ANALYSIS OF NAVAL ACTIVITY ELECTRICAL  
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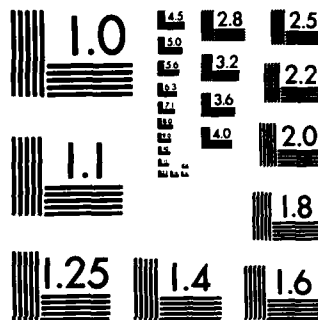
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NAVAL CIVIL ENGINEERING LABORATORY  
Port Hueneme, California

Sponsored by  
NAVY ENERGY & NATURAL RESOURCES  
R&D OFFICE  
NAVAL FACILITIES ENGINEERING COMMAND

STATISTICAL ANALYSIS OF NAVAL ACTIVITY ELECTRICAL CONSUMPTION

June 1984

An Investigation Conducted by:  
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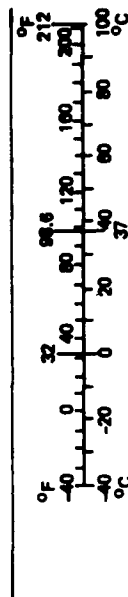
# METRIC CONVERSION FACTORS

## Approximate Conversions to Metric Measures

Symbol	When You Know	Multiply by	To Find	Symbol
in ft yd mi	inches feet yards miles	2.5 30 0.9 1.6	centimeters centimeters meters kilometers	cm m km
in <sup>2</sup> ft <sup>2</sup> yd <sup>2</sup> mi <sup>2</sup>	square inches square feet square yards square miles acres	6.5 0.09 0.8 2.6 0.4	square centimeters square meters square kilometers hectares	cm <sup>2</sup> m <sup>2</sup> km <sup>2</sup> ha
oz lb	ounces pounds short tons (2,000 lb)	28 0.45 0.9	grams kilograms tonnes	g kg t
tsp Tbsp fl oz c pt qt gal ft <sup>3</sup> yd <sup>3</sup>	teaspoons tablespoons fluid ounces cups pints quarts gallons cubic feet cubic yards	5 15 30 0.24 0.47 0.95 3.8 0.03 0.76	milliliters milliliters milliliters liters liters liters cubic meters cubic meters	ml ml ml l l l m <sup>3</sup> m <sup>3</sup>
°F	Fahrenheit temperature	5/9 (after subtracting 32)	Celsius temperature	°C

## Approximate Conversions from Metric Measures

When You Know	Multiply by	To Find	Symbol
millimeters centimeters meters meters kilometers	0.04 0.4 3.3 1.1 0.6	inches inches feet yards miles	in in ft yd mi
square centimeters square meters square kilometers hectares (10,000 m <sup>2</sup> )	0.16 1.2 0.4 2.5	square inches square yards square miles acres	in <sup>2</sup> yd <sup>2</sup> mi <sup>2</sup>
grams kilograms tonnes (1,000 kg)	0.035 2.2 1.1	ounces pounds short tons	oz lb
milliliters liters liters liters cubic meters cubic meters	0.03 2.1 1.06 0.26 35 1.3	fluid ounces pints quarts gallons cubic feet cubic yards	fl oz pt qt gal ft <sup>3</sup> yd <sup>3</sup>
Celsius temperature	9/5 (then add 32)	Fahrenheit temperature	°F



\*1 in = 2.54 (exactly). For other exact conversions and more detailed tables, see NBS Misc. Publ. 286, Units of Weights and Measures, Price \$2.25, SD Catalog No. C13.10:286.

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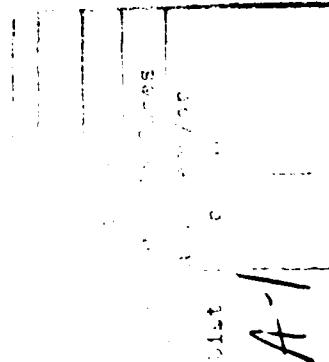
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## 1.0 INTRODUCTION

### 1.1 Objectives

The year 1975 was selected as a baseline from which the Navy established goals regarding reduction in electrical consumption. Between 1975 and 1983, electrical consumption for the Navy, as a whole, rose 12.7 percent. The objective of this analysis is to identify possible explanations for this increase.

A second objective of this study is to estimate electrical consumption factors for different facility types for both 1975 and 1983. These factors will indicate the electrical consumption per square foot area of the various facility classifications.

### 1.2 Scope

The scope of this work involves the use of statistical regression techniques to determine the statistical linear function relating electrical consumption to the price of electricity and the change in activity square footage between 1975 and 1983. This function is then used to help explain the increase in electrical consumption from the baseline year to the present. The data used in this analysis were taken from the fourth quarter 1983 DEIS II reports and data base.

To develop electrical consumption factors, the total activity electrical consumptions for 1975 and 1983 were regressed with the current square foot areas of nine different facility types. The family housing electrical consumption factor was calculated separately. The data were collected from the FACSO NFA/MAGIC data bases and the DEIS II data base. Both the NFA/MAGIC and DEIS II data used in this analysis were from the fourth quarter of 1983.

The family housing electrical consumption factor was developed from a single linear regression of the DEIS II housing consumptions with their respective square footage areas.

### 1.3 Report Format

Three chapters follow this introduction. Chapter 2 describes the concepts of multiple and simple linear regression which are both used in the analysis of the electrical consumption data. An explanation of Mallow's  $C_p$  Criterion is also presented in Chapter 2. Chapter 3 discusses the different analyses performed and the results of each. Chapter 4 highlights the conclusions and makes recommendations regarding further study.



## 2.0 STATISTICAL REGRESSION TECHNIQUES

### 2.1 Simple Linear Regression

Simple linear regression is a statistical tool which utilizes the relation between two quantitative variables so that one variable can be predicted from the other. A statistical relation is unlike a functional relation in that it is not perfect. In most cases, the observations do not fall directly on the line; there is scatter. The regression line depicts the manner in which the dependent variable tends to vary with the independent variable in a systematic fashion.

In the simple linear regression model, there is one independent variable and the function is linear. The model is shown in equation 1.

$$Y_i = \beta_0 + \beta_1 X_i + \epsilon_i \quad (1)$$

where:  $Y_i$  is the value of the response variable in the  $i$ th trial,

$\beta_0$  and  $\beta_1$  are parameters,

$X_i$  is the value of the independent variable in the  $i$ th trial, and

$\epsilon_i$  is a random error term.

In most cases, the values of  $\beta_0$  and  $\beta_1$  are not known and must be estimated from sample data. The least squares estimates of  $\beta_0$  and  $\beta_1$  ( $b_0$  and  $b_1$ ) are shown in equations 2 and 3.

$$b_1 = \frac{\sum_{i=1}^N (X_i - \bar{X})(Y_i - \bar{Y})}{\sum_{i=1}^N (X_i - \bar{X})^2} \quad (2)$$

$$b_0 = \bar{Y} - b_1 \bar{X} \quad (3)$$

where:  $\bar{X}$  is the average of the  $X_i$  values,

$\bar{Y}$  is the average of the  $Y_i$  values, and

$N$  is the number of sample data points.

The expected value of the dependent variable for a given independent variable can be predicted using equation 4.

$$\hat{Y} = b_0 + b_1 X \quad (4)$$

where:  $\hat{Y}$  is the predicted value of the independent variable,

$X$  is the desired dependent variable value, and

$b_0$  and  $b_1$  are the estimates of  $Y$  intercept and slope, respectively.

In many cases, the regression line is known to go through the origin. The model then becomes:

$$Y_i = \beta_1 X_i + \epsilon_i \quad (5)$$

The least squares estimator for  $\beta_1$  ( $b_1$ ) is shown in equation 6.

$$b_1 = \frac{\sum_{i=1}^N X_i Y_i}{\sum_{i=1}^N X_i^2} \quad (6)$$

To measure the closeness of the relationship between  $X$  and  $Y$ , the coefficient of correlation,  $R$ , is calculated. The value of  $R$  falls between  $-1$  and  $1$ . The closer the absolute value of  $R$  lies to  $1$ , the greater is said to be the degree of association between  $X$  and  $Y$ . For a simple linear regression, the coefficient of correlation is calculated as shown in equation 7.

$$R = \frac{\sum_{i=1}^N (X_i - \bar{X})(Y_i - \bar{Y})}{\left[ \sum_{i=1}^N (X_i - \bar{X})^2 \sum_{i=1}^N (Y_i - \bar{Y})^2 \right]^{\frac{1}{2}}} \quad (7)$$

## 2.2 Multiple Linear Regression

In a multiple linear regression model, there are numerous independent variables and the function is linear as shown in equation 8.

$$Y_i = \beta_0 + \beta_1 X_{i1} + \beta_2 X_{i2} + \dots + \beta_{p-1} X_{i,p-1} + \varepsilon_i \quad (8)$$

In nearly all cases, the least squares estimates of the parameters  $\beta_0, \beta_1, \dots, \beta_{p-1}$  are calculated using commercial computer software packages such as BMDP and SPSS. Matrix inversion is required in the solution which necessitates tremendous amounts of computation. For a more detailed discussion of multiple linear regression models, the reader is referred to reference 1.

Once the least squared estimates of  $\beta_0, \beta_1, \dots, \beta_{p-1}$  have been calculated, the dependent variable,  $Y$ , can be estimated for given levels of the independent variables, using equation 9.

$$\hat{Y} = b_0 + b_1 X_1 + b_2 X_2 + \dots + b_{p-1} X_{p-1} \quad (9)$$

The coefficient of correlation,  $R$ , indicates the reduction of the total variation in  $Y$  associated with the use of the set of  $X$  variables. When all observations fall in the fitted response surface,  $R$  assumes a value of 1. The coefficient of correlation for a multiple linear regression is calculated most efficiently through the use of a standard multiple regression software package. The equation for  $R$ -multiple is shown below:

$$R = \frac{\sum_{i=1}^N (\hat{Y}_i - \bar{\hat{Y}})(Y_i - \bar{Y})}{\left[ \sum_{i=1}^N (\hat{Y}_i - \bar{\hat{Y}})^2 \sum_{i=1}^N (Y_i - \bar{Y})^2 \right]^{1/2}} \quad (10)$$

where:  $\bar{\hat{Y}}$  is the average of the predicted values  $\hat{Y}_i$  and

$\hat{Y}_i$  is the predicted value for given values of  $X_{i1}, X_{i2}, \dots, X_{ip-1}$ .

### 2.3 Mallows's $C_p$ Criterion

A large absolute value of  $R$  does not necessarily imply that the fitted model is a useful one. Observations may have been taken at only a few levels of

the independent variables. Despite a large magnitude of  $R$ , the fitted model may not be useful because predictions would require extrapolations outside the region of observations. For any data set, adding more independent variables will increase the value of  $R$ . However, an independent variable may not be fundamental to the problem, or it may effectively duplicate another variable. The problem becomes how to shorten the list of independent variables to achieve the "best" set of independent variables.

The Mallows's  $C_p$  Criterion is concerned with the total squared error of the  $N$  fitted observations. The error,  $E_i$ , is equal to the observed minus the predicted value as shown in equation 11.

$$E_i = Y_i - \hat{Y}_i \quad (11)$$

where:  $\hat{Y}_i = b_0 + b_1 X_i$

The  $C_p$  Criterion has a component which includes the sum of the error terms squared and a component with the number of independent variables ( $p$ ) included in the model. The objective is to find a set of independent variables which produces a minimum  $C_p$ . All possible subsets are tested; the set of best independent variables is defined as that which produces the smallest  $C_p$ . Equation 12 shows the calculation for  $C_p$ .

$$C_p = \frac{SSE_p}{MSE_F} - (N - 2p) \quad (12)$$

where:  $F$  is the maximum number of independent variables,

$SSE_p$  is the sum of the error terms squared for the model with  $p$  independent variables, and

$MSE_F$  is the mean square error for the full model (all possible independent variables included)  $MSE_F = SSE_F / (N - F)$ .

## 2.4 Correlation in the Independent Variables

The coefficient of correlation,  $R$ , serves as an indication of the degree of relationship between the dependent and independent variables. It can also be used to provide information about the degree of relationship between two independent variables,  $X_j$  and  $X_k$ . The correlation coefficient for two independent variables is depicted as  $R_{jk}$  and calculated as shown in the following equation:

$$R_{jk} = \frac{\sum_{i=1}^N (X_{ji} - \bar{X}_j)(X_{ki} - \bar{X}_k)}{[\sum_{i=1}^N (X_{ji} - \bar{X}_j)^2 \sum_{i=1}^N (X_{ki} - \bar{X}_k)^2]^{\frac{1}{2}}} \quad (2.1)$$

A magnitude of  $R_{jk}$  close to unity indicates a high degree of correlation between the two variables.

### 3.0 ANALYSIS OF DATA

#### 3.1 Description of Analyses

As mentioned in Chapter 1, the electrical consumption Navy-wide rose approximately 12.7 percent between the baseline year and the fourth quarter of 1983. To explain this relationship, several statistical analyses were performed. Each analysis will be presented in this chapter with its corresponding results. The development of the electrical consumption factors will be presented first, followed by the analysis of the change in consumption between 1975 and 1983.

#### 3.2 Electrical Consumption Factors

The electrical consumption at any naval activity is directly related to the type, number, and size of its facilities. Data are available in the DEIS II quarterly reports that give the annual electrical consumption (in MBtus) and square foot area for each naval activity for both the current and baseline year. The activities are identified by DEIS II Unit Identification Codes (UICs); family housing activities begin with the letter D, and all the facility types are included under a UIC beginning with the letter N. For example, the DEIS II UICs for the Naval Air Station in Corpus Christi, Texas, are D00216 and N00216 for the family housing facilities and all other naval shore facilities, respectively.

The NFA/MAGIC data base, maintained by FACSO, contains information for each individual naval facility. Software was developed to extract the facility square foot areas for the UICs contained within the following states:

- Alabama
- Arizona
- California
- Connecticut
- Delaware
- District of Columbia
- Florida
- Georgia
- Louisiana
- Maryland
- Massachusetts
- Mississippi
- New Jersey
- New Mexico
- New York
- North Carolina
- Oregon
- Rhode Island
- South Carolina
- Texas
- Virginia
- Washington

This software is described in detail in reference 2. The facility types and their respective Category Code/Nomenclatures (CCNs) selected for this analysis are shown below:

<u>Group Number</u>	<u>Facility Description</u>	<u>Prime Use CCNs</u>
1	Port Facilities	11100-16999
2	Training	17000-19999
3	Maintenance	20000-21999
4	Production	22000-29999
5	Laboratories	30000-39999
6	Storage	40000-49999
7	Medical	50000-54999
8	Dispensaries	55000-59999
9	Administration	60000-69999
10	Troop Housing	72100-72999
11	Community	73000-79999
12	Utilities	80000-89999

Family housing facilities, CCNs 70000 through 72099, will be covered in a separate analysis because of their special classification in the DEIS II data base. The 22 states listed above contain 228 naval activities. The current facility square footage areas for each activity are shown with the total base electrical consumptions for 1983 and 1975 in Appendix A. The DEIS II data base also contains a measure of the square footage area for temporary buildings such as construction trailers which use electricity but are not contained in the HFA/MAGIC data base. The square foot areas for the temporary structures are also shown in Appendix A. To determine the electrical consumption factors for each facility type, the following model was hypothesized.

$$\begin{aligned} ELE_i = & \beta_0 * SQFTOT_i + \beta_1 * SQFT1_i + \beta_2 * SQFT2_i + \beta_3 * SQFT3_i + \beta_4 * SQFT4_i + \\ & \beta_5 * SQFT5_i + \beta_6 * SQFT6_i + \beta_7 * SQFT7_i + \beta_8 * SQFT8_i + \beta_9 * SQFT9_i + \\ & \beta_{10} * SQFT10_i + \beta_{11} * SQFT11_i + \beta_{12} * SQFT12_i + \epsilon_i \end{aligned} \quad (14)$$

where:  $ELE_i$  is the electrical consumption in MBtus for activity  $i$  minus the family housing consumption for either 1983 or 1975;

$SQFTOT_i$  is the temporary facility square footage area for activity  $i$ ;

$SQFT1_i$  is the port facility square footage area for activity  $i$ ;

$SQFT2_i$  is the training square footage area for activity  $i$ ;

$SQFT3_i$  is the maintenance square footage area for activity  $i$ ;

$SQFT4_i$  is the production square footage area for activity  $i$ ;

$SQFT5_i$  is the laboratories square footage area for activity  $i$ ;

$SQFT6_i$  is the storage square footage area for activity  $i$ ;

$SQFT7_i$  is the medical square footage area for activity  $i$ ;

$SQFT8_i$  is the dispensary square footage area for activity  $i$ ;

$SQFT9_i$  is the administration square footage area for activity  $i$ ;

$SQFT10_i$  is the troop housing square footage area for activity  $i$ ;

$SQFT11_i$  is the community square footage area for activity  $i$ ;

$SQFT12_i$  is the utility square footage area for activity  $i$ ; and

$\epsilon_i$  is an error term.

To determine the least squares estimates of the coefficients  $\beta_0, \beta_1, \dots, \beta_{12}$ , a computerized version of Mallows's  $C_p$  technique was used. The software is documented in reference 2. The "best" set results of the  $C_p$  analysis for 1983 and 1975 are contained in Table 1.



Table 1. Regression Results for Mallow's  $C_p$  Analysis

Facility Type	Variable Name	Regression Coefficient, $b[\text{MBtu}/\text{ft}^2]$	
		Baseline Year, 1975*	Current Year, 1983
Temporary	SQFTOT	0.140227	0.256889
Training	SQFT2	0.0878216	0.186324
Maintenance	SQFT3	0.288121	0.377864
Production	SQFT4	0.483617	0.387691
Laboratories	SQFT5	0.304718	0.336881
Storage	SQFT6	0.0250001	0.0339457
Medical	SQFT7	0.162382	0.361043
Administration	SQFT9	0.153715	0.211236
Troop Housing	SQFT10	0.186402	0.150921
Correlation Coefficient, R		0.95228	0.94370

\*The current square footage areas were used for this analysis because the 1975 areas were not available.

The 1975 electrical consumptions, when regressed with the 1983 facility square footage data, should result in lower factors because less electrical consumption is spread over a larger activity square footage. For this reason, these figures should be used cautiously.

In the case of this regression, the resulting factors are overall on the high side because certain facilities were removed from the regression due to correlations with other facilities. For example, SQFT1 (port facilities) were highly correlated with storage facilities. Similarly, dispensaries (SQFT8) were strongly related to the medical facilities. Community (SQFT11) and utility (SQFT12) facilities were excluded due to a correlation with troop housing. Combining the correlated facilities gives the following facility classifications:

Variable Name	Facility Description	Prime Use CCNs
SQFT0T	Temporary Structures	--
SQFT1	Port Facilities and Storage	11100-16999, 40000-49999
SQFT2	Training	17000-19999
SQFT3	Maintenance	20000-21999
SQFT4	Production	22000-29999
SQFT5	Laboratories	30000-39999
SQFT6	Medical and Dispensaries	50000-59999
SQFT7	Administration	60000-69999
SQFT8	Troop Housing, Community and Utilities	72100-89999

Employing Mallow's  $C_p$  Multiple Linear Regression techniques to the new classifications yields the results shown in Table 2.

Table 2. Mallow's  $C_p$  Results for New Facility Classifications

Facility Type	Variable Name	Regression Coefficient, $b[\text{MBtu/ft}^2]$	
		Baseline Year, 1975*	Current Year, 1983
Temporary Structures	SQFT0T	0.11557	0.233444
Port Facilities and Storage	SQFT1	0.01909	0.0279635
Training	SQFT2	0.11307	0.201617
Maintenance	SQFT3	0.28415	0.373056
Production	SQFT4	0.48714	0.391705
Laboratories	SQFT5	0.30210	0.334136
Medical and Dispensaries	SQFT6	0.11959	0.297953
Administration	SQFT7	0.11529	0.174109
Troop Housing, Community and Utilities	SQFT8	0.11151	0.0943252
Correlation Coefficient, R		0.95180	0.94322

\*As in the last analysis, these values were determined using the current square footage data.

These current year coefficients, when multiplied by the square footage areas will provide an estimate of the yearly base consumption in units of MBtus as shown in equation 15.

$$\begin{aligned} \hat{ELE} = & 0.233444SQFTOT + 0.0279635SQFT1 + 0.201617SQFT2 + \\ & 0.373056SQFT3 + 0.391705SQFT4 + 0.334136SQFT5 + \\ & 0.297953SQFT6 + 0.174109SQFT7 + 0.0943252SQFT8 \end{aligned} \quad (15)$$

To determine the electrical consumption factors for the family housing facilities, the DEIS II UIC data for the family housing activities were used. A simple linear regression analysis was performed on the data for both the baseline and present year. Electrical consumption in MBtus was regressed with the total square footage area for the housing activities. The data used in the analysis are listed in Appendix B. The following model was selected.

$$ELE_i = \beta_9 * SQFT9_i + \epsilon_i \quad (16)$$

where:  $SQFT9_i$  is the total family housing square footage at activity i,

$ELE_i$  is the total electrical consumption in MBtus for activity i, and

$\epsilon_i$  is a random error term.

Utilizing regression software, the family housing electrical consumption factors shown in Table 3 were developed.

Table 3. Family Housing Electrical Consumption Factors

Year	Family Housing Electrical Consumption Factor, $b_9$ [MBtu/ft <sup>2</sup> ]	Correlation Coefficient
1975	0.122017	0.88609
1983	0.109837	0.90817

The per square foot electrical consumption appears to have decreased by 10 percent from 1975 to 1983.

### 3.3 Regression Analysis of Electrical Consumption Changes

To explain the average increase in electrical consumption from 1975 to 1983, the change in consumption was regressed with the following two factors:

- (1) DIFF, change in activity square footage from 1975 to 1983
- (2) COST, unit cost of electricity in units of \$/KWHr.

Because the overall base consumption is highly related to facility square footage, the change in square footage should reflect a change in consumption. Similarly, the unit cost of electricity can be used to predict a change in electrical consumption. The unit cost of electricity is important in the decision of whether to fund energy savings alternatives. In locations where the cost of electricity is high, energy savings projects can be economically justified. Therefore, the electrical consumption should decrease in the high cost areas because energy savings programs can be justified and implemented. The change in electrical consumption can be expressed in the following ways:

- (1) DELE, change in consumption from 1975 to 1983 [MBtu]
- (2) PER, percent change in consumption from 1975 to 1983 [%]
- (3) ESQFT, change in consumption from 1975 to 1983 per 1983 square footage area [MBtu/ft<sup>2</sup>].

To explain the change in consumption, the following regression analyses were performed.

- (1) DELE vs. COST
- (2) PER vs. COST
- (3) ESQFT vs. COST
- (4) DELE vs. DIFF
- (5) DELE vs. DIFF and COST.

The results are presented in Table 4.

Table 4. Prediction Models for Change in Electrical Consumption

Dependent Variable	Regression Relation	Correlation Coefficient, R
DELE	$50356 - 0.42530 \times 10^6 \text{ COST}$	0.1296
PER	$17.779 - 132.88 \text{ COST}$	0.1047
ESQFT	$0.04898 - 0.55615 \text{ COST}$	0.1111
DELE	$14483 + 0.11290 \text{ DIFF}$	0.3690
DELE	$41612 - 0.42186 \times 10^6 \text{ COST} + 0.11279 \text{ DIFF}$	0.3907

In all cases, the change in electrical consumption between 1975 and 1983 was inversely proportioned to the unit cost of electricity (COST) and directly proportional to the change in square footage area (DIFF). Although the correlation coefficients are fairly small, a slight relationship is present in each case. The models which include the change in square foot area are generally better than the models which include only cost as the independent variable.

Utilizing the fifth model, the estimated unit cost of electricity at which energy savings alternatives were justified is calculated by inserting the average change in square foot area from 1975 to 1983 ( $75563.38 \text{ ft}^2$ ) and setting the change in electrical consumption to zero.

$$\text{DELE} = 41612.44556 - 0.42186 \times 10^6 \text{ COST} + 0.11279 \text{ DIFF}$$

$$0 = 41612.44556 - 0.42186 \times 10^6 \text{ COST} + (0.11279)(75563.38)$$

$$\text{COST} = 0.119 \text{ \$/KWHr}$$

For an activity with average growth, the estimated cost for justification of energy savings alternatives was 0.119 \$/KWHr.

#### 4.0 SUMMARY AND CONCLUSIONS

##### 4.1 Significant Results

A model which predicts the total annual base consumption was developed.

The following electrical consumption factors for 1983 were calculated.

Production	0.391705 MBtu/ft <sup>2</sup>	33.768 KWHr/ft <sup>2</sup>
Maintenance	0.373056 MBtu/ft <sup>2</sup>	32.610 KWHr/ft <sup>2</sup>
Laboratories	0.334136 MBtu/ft <sup>2</sup>	28.805 KWHr/ft <sup>2</sup>
Medical/Dispensaries	0.297953 MBtu/ft <sup>2</sup>	25.685 KWHr/ft <sup>2</sup>
Temporary Structures	0.233444 MBtu/ft <sup>2</sup>	20.124 KWHr/ft <sup>2</sup>
Training	0.201617 MBtu/ft <sup>2</sup>	17.381 KWHr/ft <sup>2</sup>
Administration	0.174109 MBtu/ft <sup>2</sup>	15.009 KWHr/ft <sup>2</sup>
Family Housing	0.109837 MBtu/ft <sup>2</sup>	9.469 KWHr/ft <sup>2</sup>
Troop Housing/Community/ Utilities	0.0943252 MBtu/ft <sup>2</sup>	8.131 KWHr/ft <sup>2</sup>
Port Facilities/Storage	0.0279635 MBtu/ft <sup>2</sup>	2.411 KWHr/ft <sup>2</sup>

The storage facilities consumption factor is an order of magnitude lower than the other facilities. Production facilities use the most electricity per square foot, closely followed by maintenance, laboratory, and medical facilities.

Table 5 shows the average area for each facility type for the 228 activities included in the analysis. The percent of the total area for each of these classifications is also shown. The family housing facilities contribute the most to the square footage area. Port facilities and storage, troop housing, and maintenance facilities are also area intensive.

Using the total facility areas and the electrical consumption factors for 1983, Table 6 was developed. Several significant results should be noted.

Table 5. Average Area Per Activity for 228 Activities

Facility Type	Average Area Per Base (ft <sup>2</sup> )	Percent of Total
Temporary Structures	48,283	3.17
Port Facilities and Storage	289,342	18.98
Training	95,249	6.25
Maintenance	245,907	16.13
Production	41,303	2.71
Laboratories	74,838	4.91
Medical and Dispensaries	48,118	3.16
Administration	103,592	6.80
Troop Houaing, Community, and Utilities	279,955	18.36
Family Housing	297,829	19.54

Table 6. Average Electrical Use Per Activity for 228 Activities

Facility Type	Rate of Use (MBtus/ft <sup>2</sup> )	Average Activity Consumption (MBtus)	Percent of Total
Temporary Structures	0.233444	11,271	4.29
Port Facilities and Storage	0.0279635	8,091	3.08
Training	0.201617	19,204	7.30
Maintenance	0.373056	91,737	34.88
Production	0.391705	16,179	6.15
Laboratories	0.334136	25,006	9.51
Medical and Dispensaries	0.297953	14,337	5.45
Administration	0.174109	18,036	6.86
Troop Housing, Community, and Utilities	0.0943252	26,407	10.04
Family Housing	0.109837	32,713	12.44

- o Maintenance facilities consume almost 35% of the total electricity with only 16.13% of the total area.
- o Storage facilities, due to their low consumption factor, use only 3% of the total consumption while occupying 18.98% of the total area.
- o Both family and troop housing facilities use considerably less electricity proportionately than area.

Figures 1 and 2 graphically illustrate these results.

Similar coefficients were developed for the baseline electrical consumptions; however, current square footage measurements were used. This decreases the magnitude of the consumption factors, making them unrepresentative of the actual consumption factors.

The change in electrical consumption was regressed against the unit cost of electricity and the change in square foot area between 1975 and 1983. The consumption was found to vary inversely with cost and directly with change in area. A cost of 0.119 \$/KWHr was estimated as the unit cost of electricity above which energy savings alternatives were economically justified.

Figure 3 uses a scatter diagram to best illustrate the unit cost of electricity versus the change in electrical consumption for each activity from 1975 to 1983. For 393 activities, the average cost of electricity was \$0.0643/KWHr, and the average increase in electrical consumption was 23,000 MBtus over the period 1975 to 1983.



**AREA AND ELECTRICAL USE DATA FOR 228 ACTIVITIES  
(PERCENTS IN PARENTHESIS)**

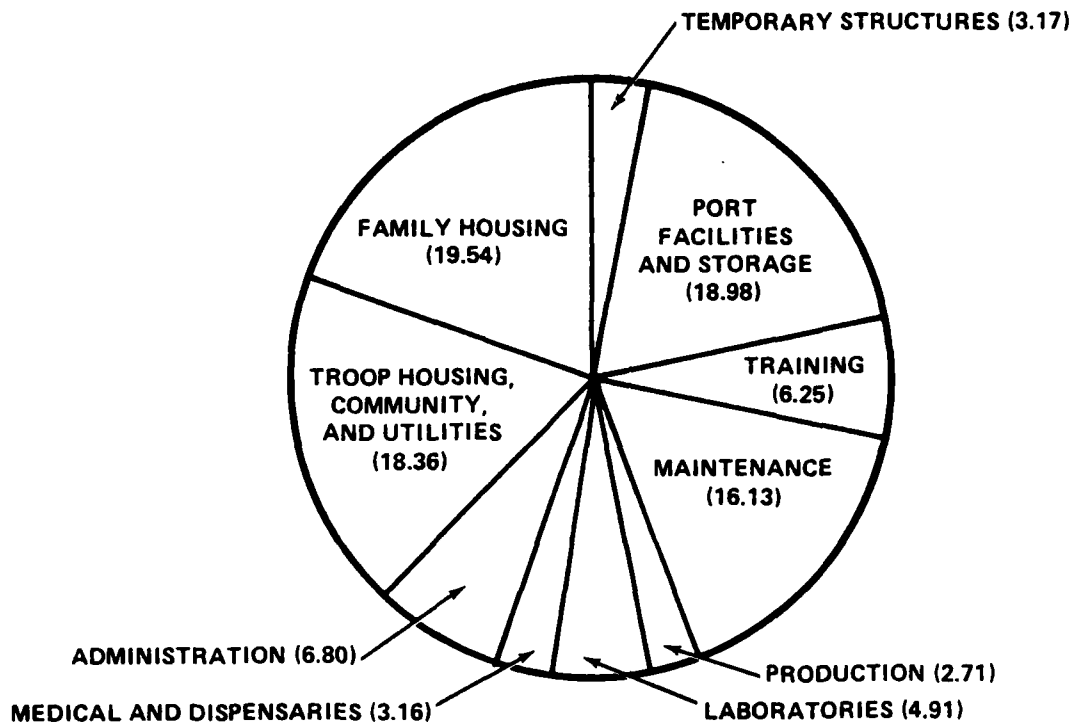


Figure 1. Mean Area Per Activity

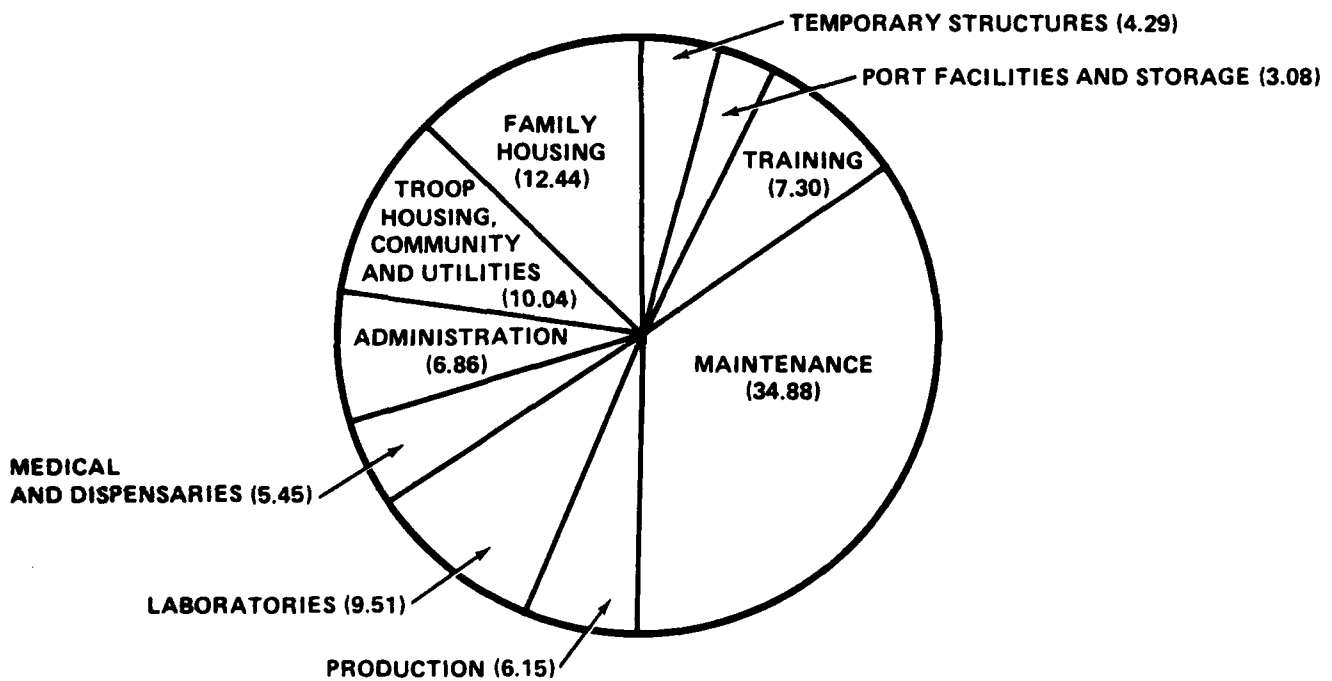


Figure 2. Mean Electrical Use Per Activity

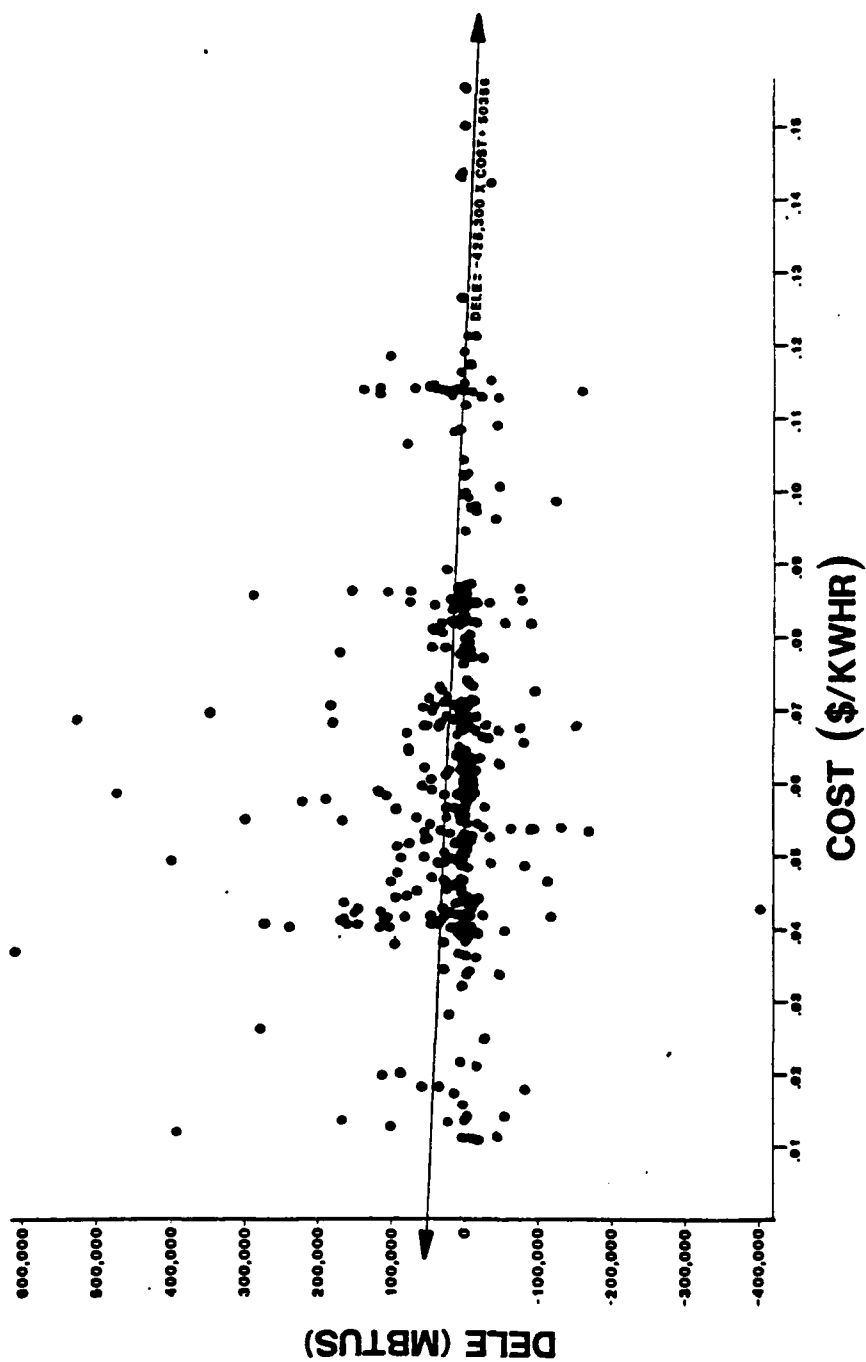


Figure 3. Change in Electrical Consumption (DELE) as a Function of Electricity Cost (COST)

#### 4.2 Recommendations

The relationship between current electrical consumption and facility square footage area was found to have a strong correlation ( $R = 0.94322$ ). If facility square footage data could be obtained for the baseline year, a similar model could be developed. A comparison between these factors would yield the best information about the increase in electrical consumption between 1975 and the present.

It is recommended that the percent model be used to determine which activities consume much greater amounts of electricity than expected, based on their facility square footages. This can be accomplished through a comparative analysis of predicted versus actual consumptions for the Navy activities included in this study.

#### REFERENCES

1. Neter, John and William Wasserman, Applied Linear Statistical Models, Richard D. Irwin, Inc., Homewood, Illinois, 1974.
2. deMonsabert, Sharon, A User's Guide to the Navy's Electrical Analysis Software System, developed for NCEL under Contract No. N00123-82-D-0149, Task Order J3-76, March 1984.

APPENDIX A  
FACILITY SQUARE FOOTAGE AREAS  
AND ELECTRICAL CONSUMPTION

Table A-1. Facility Square Footage Areas and Electrical Consumption

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Table A-1. Facility Square Footage Areas and Electrical Consumption (Continued)

DLIS Electrical II Consumption UTC	1983 [Btu]*	1975 [Mbtu]	Consumption														SQFT10		SQFT11		SQFT12	
			SQFT1	SQFT2	SQFT3	SQFT4	SQFT5	SQFT6	SQFT7	SQFT8	SQFT9	SQFT10	SQFT11	SQFT12	[ft <sup>2</sup> ]		[ft <sup>2</sup> ]		[ft <sup>2</sup> ]		[ft <sup>2</sup> ]	
N00750	11306.0	20861.2	-47913	0	397021	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
N00751	29670.0	24974.8	36340	12000	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
N00752	194004.4	238577.2	11000	65492	551443	0	21670	165982	0	10719	0	161961	0	0	0	0	0	0	0	0	0	0
N00753	478458.4	364019.6	226709	270309	318889	0	0	145832	0	73037	0	17266	0	0	0	0	0	0	0	0	0	0
N00754	628530.0	773287.6	2321	9145	839173	8677	0	140695	22029	86804	0	180598	0	0	0	0	0	0	0	0	0	0
N00755	282402.0	394887.2	-111829	66043	1280	2864	0	435701	10248	39130	0	195327	0	0	0	0	0	0	0	0	0	0
N00756	13627.2	23211.6	25818	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
N00757	14430.4	18031.2	39950	0	232224	6240	0	248742	0	0	0	0	0	0	0	0	0	0	0	0	0	0
N00758	942407.2	988737.6	18174	73956	19633	5724	1674162	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
N00759	52223.2	62442.8	0	0	19633	4342	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
N00760	860689.6	560280.0	-5478	97171	322765	11102	22140	535345	1724	9853	0	286067	0	0	0	0	0	0	0	0	0	0
N00761	114712.4	118876.8	252451	21012	257686	119778	0	438240	0	33992	0	173019	0	0	0	0	0	0	0	0	0	0
N00762	257056.0	268366.0	14821	48733	86163	388138	0	69608	0	26637	0	305384	0	0	0	0	0	0	0	0	0	0
N00763	84587.2	62883.6	0	0	0	109968	2911	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
N00764	15254.0	6681.6	17430	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
N00765	332409.6	290812.0	2800	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
N00766	521605.6	568980.0	96700	170436	178501	552086	1305277	42792	0	1080	0	39409	0	0	0	0	0	0	0	0	0	0
N00767	88872.4	63669.6	476	0	960	4048	0	9010	0	18792	0	328813	0	0	0	0	0	0	0	0	0	0
N00768	88914.0	93275.2	8000	51299	0	12880	0	4998	0	0	0	5129	0	0	0	0	0	0	0	0	0	0
N00769	135279.2	135279.2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
N00770	129827.2	69344.8	-17502	5280	0	11192	0	40438	367688	2465	0	48262	0	0	0	0	0	0	0	0	0	0
N00771	64032.0	71630.4	384	21027	49202	416775	0	48271	846369	76544	0	108307	0	0	0	0	0	0	0	0	0	0
N00772	962.8	1206.4	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
N00773	57246.0	53510.8	7965	5866	29915	135162	0	54591	0	24050	0	83830	0	0	0	0	0	0	0	0	0	0
N00774	15184.4	22828.8	1170	0	0	0	0	0	0	0	0	82500	0	0	0	0	0	0	0	0	0	0
N00775	3897.6	452.4	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
N00776	33721.2	28605.6	480	0	168506	3649	0	2123	0	0	0	392	0	0	0	0	0	0	0	0	0	0
N00777	76594.8	59600.8	13087	0	0	323288	0	1266	0	0	0	33444	0	0	0	0	0	0	0	0	0	0
N00778	22712.8	32306.0	176161	191330	420	48048	64	14975	0	0	0	110570	0	0	0	0	0	0	0	0	0	0
N00779	735300.8	95072.8	130582	191330	420	48048	64	14975	0	0	0	110570	0	0	0	0	0	0	0	0	0	0
N00780	225585.2	279745.6	1912	80491	124310	124050	2450	226039	19981	19070	0	366986	0	0	0	0	0	0	0	0	0	0
N00781	1452702.8	48138.8	58973	2587	34883	3277327	0	121	1709371	45187	0	88189	0	0	0	0	0	0	0	0	0	0
N00782	482026.4	413366.0	-43208	1570	1134191	96387	1920	136585	0	0	0	182103	0	0	0	0	0	0	0	0	0	0
N00783	350528.8	243058.8	-318426	427822	158254	348402	163446	903	8146787	7726	0	536972	0	0	0	0	0	0	0	0	0	0
N00784	200308.8	171656.8	2000	0	280898	210	0	144	0	0	0	0	0	0	0	0	0	0	0	0	0	0
N00785	10927.2	10927.2	0	3200	0	2810	0	64025	832	0	0	0	0	0	0	0	0	0	0	0	0	0
N00786	363230.8	78813.2	0	188354	0	198576	0	5424394	0	7530	0	82225	0	0	0	0	0	0	0	0	0	0
N00787	100166.0	78813.2	0	22637	8000	382233	0	67851	0	13255	0	117700	0	0	0	0	0	0	0	0	0	0
N00788	17214.4	14917.6	0	17498	0	8455	0	4200	0	744	0	25167	0	0	0	0	0	0	0	0	0	0
N00789	1948.8	1948.8	0	2066	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
N00790	217407.2	80593	1319	80593	226414	200928	0	1952196	0	629	0	297945	0	0	0	0	0	0	0	0	0	0
N00791	10428.4	0	0	206	0	62149	0	6463	1346	0	0	292974	0	0	0	0	0	0	0	0	0	0
N00792	15126.4	15126.4	0	0	0	4723	0	324	520	0	0	0	0	0	0	0	0	0	0	0	0	0
N00793	127646.4	138109.6	23310	10912	181481	21303	0	14289	0	0	0	37689	0	0	0	0	0	0	0	0	0	0
N00794	7331.2	8020.4	17479	18783	0	358897	0	289774	0	0	0	2505	0	0	0	0	0	0	0	0	0	0
N00795	433132.4	118614.8	107253	35751	2399	358897	0	289774	0	0	0	74200	0	0	0	0	0	0	0	0	0	0
N00796	5440.4	4384.8	4500	0	0	22705	0	58953	14765	0	0	21491	0	0	0	0	0	0	0	0	0	0
N00797	49594.4	49594.4	0	0	388861	0	0	30000	0	0	0	0	0	0	0	0	0	0	0	0	0	0
N00798	24081.6	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
N00799	150544.8	64128	35126	64128	41490	504405	0	8997	0	16622	0	21449	0	0	0	0	0	0	0	0	0	0
N00800	88171.6	225982	225982	4590	48334	280652	595683	223710	0	9525	0	16822	0	0	0	0	0	0	0	0	0	0
N00801	95902.8	95902.8	82	0	286498	18892	7974	0	0	0	0	9525	0	0	0	0	0	0	0	0	0	0
N00802	9688.0	9688.0	-5251	0	22893	0	0	47186	0	0	0	129853	0	0	0	0	0	0	0	0	0	0
N00803	105768.8	105768.8	23554	0	0	16431	0	0	0	0	0	368873	0	0	0	0	0	0	0	0	0	0
N00804	29700.8	29700.8	-13536	217152	348608	363240	4800	48785	1772312	8590	0	21190	0	0	0	0	0	0	0	0	0	0
N00805	88544.4	88544.4	911	0	0	15708	0	527	0	0	0	81647	0	0	0	0	0	0	0	0	0	0
N00806	5022.8	5022.8	0	0	56101	13645	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
N00807	19105.2	19105.2	0	0	635114	130279	0	2766	3121333	0	0	0	0	0	0	0	0	0	0	0	0	0
N00808	224286.0	146972.0	8775	335438	8140	130279	2160	3600	299780	0	0	2304	0	0	0	0	0	0	0	0	0	0
N00809	1062848.4	1078923.2	8498	1608	58218	2052790	826	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
N00810	41307.6	38117.6	114382	5068	0	195106	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
N00811	874896.0	874896.0	110320	2500	0	18864	1281067	0	0	0	0	413289	0	0	0	0	0	0	0	0	0	0
N00812	105026.4	68484.0	68484	63333	26311	26842	0	0	0	0	0	936132	0	0	0	0	0	0	0	0	0	0
N00813	76028.4	44091.6	-39117	26311	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0

\*Conversion factor: 11.6 MBtu = 1 MWhr

Table A-1. Facility Square Footage Areas and Electrical Consumption (Continued)

DEIS II UIC	1983 Electrical Consumption [MBtu]*	1975 Electrical Consumption [MBtu]	SQFTOT [ft <sup>2</sup> ]	SQFT1 [ft <sup>2</sup> ]	SQFT2 [ft <sup>2</sup> ]	SQFT3 [ft <sup>2</sup> ]	SQFT4 [ft <sup>2</sup> ]	SQFT5 [ft <sup>2</sup> ]	SQFT6 [ft <sup>2</sup> ]	SQFT7 [ft <sup>2</sup> ]	SQFT8 [ft <sup>2</sup> ]	SQFT9 [ft <sup>2</sup> ]	SQFT10 [ft <sup>2</sup> ]	SQFT11 [ft <sup>2</sup> ]	SQFT12 [ft <sup>2</sup> ]
N60200	63484.6	415813.6	151235.	100129	224945	1064121	0	0	188403	0	46800	120394	616346	245830	21952
N60201	771608.8	826284.0	8764.	442	0	2496814	0	0	0	0	0	31645	0	0	7459
N60202	12516.4	13212.4	0	460	312112	7800	0	0	0	0	0	0	0	0	12366
N60203	20543.6	24302.0	-22534.	36907	153846	130330	984	0	0	0	0	42780	0	0	480
N60204	425731.6	508060.0	64255.	36907	153846	833559	984	0	0	0	0	46780	0	0	37707
N60205	216676.4	53719.6	5956.	6407	36245	833559	0	194363	800	318094	43933	11944	31010	3622	3780
N60206	231130.0	0	0	6407	0	421248	0	0	43058	0	0	204390	909	0	10308
N60207	745556.8	249806.0	249806.	21310	0	2141566	0	0	0	0	0	0	0	319	0
N60208	20172.4	0	0	0	0	0	0	0	0	0	0	0	0	0	0
N60209	269027.2	15880.	15880.	0	66272	60435	0	0	60680	0	0	21080	85140	0	22776
N60210	24796.4	834368.	834368.	13144	49829	2559726	14792	0	747289	22850	12254	633711	214069	592057	121121
N60211	1889173.2	69670.	69670.	19200	19200	276872	0	1344	261271	0	0	243216	714135	441697	62526
N60212	64426.4	10599	0	10599	0	0	0	0	0	0	0	0	0	0	0
N60213	5648.8	7157.2	0	71261	0	87671	0	640781	122552	0	8856	62832	59017	108198	11686
N60214	307808.8	134466.	134466.	10116	1940	7689	0	0	2986	0	0	2628	19798	14139	1925
N60215	13583.6	125.	125.	0	256474	14253	0	91897	76000	0	0	0	0	0	0
N60216	10426.4	800	800	0	640	41774	0	70260	280	0	0	179172	0	0	4296
N60217	87104.4	11731	98989	320	382205	8550	6700	0	0	0	0	97514	0	5918	487
N60218	22701.2	18064.4	0	0	0	10116	0	0	11156	0	0	31950	0	0	0
N60219	19064.4	214901.	3214.	0	0	0	0	0	0	0	0	0	0	0	0
N60220	10474.8	5872.4	0	0	0	0	0	23449	1215	0	0	0	0	0	0
N60221	113413.2	125825.2	0	0	203953	109864	10777	1008	1408532	25175	0	257748	595838	975145	57600
N60222	849514.4	667301.6	225040.	136398	10251	369787	3679	3234	350038	0	10444	80076	35472	74884	17291
N60223	161298.0	138863.6	8000.	19897	0	0	0	91202	817051	0	17102	141172	122207	128943	27556
N60224	37700.0	16727.2	0	213818	4261	889311	359382	0	8425	0	0	4586	0	13131	6001
N60225	293712.0	275117.2	0	12777	0	16769	0	0	0	0	0	181322	0	0	0
N60226	4419.6	0	0	0	0	0	0	0	0	0	0	0	0	0	0
N60227	28014.0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
N60228	11820.4	0	10574.	7756	0	640	0	0	100	0	0	0	464911	0	0
N60229	242324.4	242324.4	10574.	110037	240828	171910	0	0	1222725	0	22378	208422	222062	212062	8479
N60230	44207.6	44207.6	0	37571	91001	2526	0	0	49325	0	260513	260513	71447	23212	0
N60231	435626.4	435626.4	2483235.	50448	82709	424606	0	55466	73595	21012	65800	227393	217512	514288	214954
N60232	1105839.6	417391.2	86629.	0	830965	77061	0	166492	12085	1571227	17420	194915	217512	1126693	28555
N60233	111336.8	111336.8	86629.	58697	0	4456	26720	0	1381268	0	0	32109	0	3591	690
N60234	25902.8	3720.	3720.	0	134240	0	0	0	4088	0	0	0	0	0	800
N60235	201844.4	0	0	0	0	0	0	0	2472	411088	0	0	19456	4724	0
N60236	58517.	58517.	0	5235	2700	27208	0	407037	36300	0	0	2584	0	9343	216
N60237	177849.6	177849.6	1700.	34154	4970	329511	1178	9018	75214	0	10357	24345	135776	155282	23670
N60238	151913.6	0	0	0	0	0	0	95525	0	0	0	23501	0	0	0
N60239	23130.4	0	0	1148	0	32181	157786	209372	138114	9905	0	96969	0	9454	9349
N60240	200078.8	3000.	3000.	35326	131544	759407	8439	0	819885	0	0	184724	488840	490059	38317
N60241	430290.4	0	0	2252	0	0	0	0	0	0	0	0	0	0	0
N60242	12850.4	0	0	0	60530	151740	0	645921	64110	0	1480	150390	50390	324	0
N60243	191701.6	10200.	10200.	27945	0	172882	0	0	0	0	0	28806	0	18318	147036
N60244	19464.8	-6453.	0	6803	353288	3170	0	0	100	0	0	0	0	540	0
N60245	33396.4	0	0	0	0	0	0	0	0	226039	0	0	0	0	5617
N60246	39706.8	0	0	139505	0	0	0	1248	0	0	0	0	0	0	0
N60247	28675.2	0	0	21632	0	80767	0	0	35244	0	0	481267	48115	165295	7169
N60248	108239.6	0	0	0	0	17052	0	0	4512	0	0	0	2045	0	0
N60249	24394.8	0	0	4284	366986	17052	0	0	2718	0	0	0	21769	13583	1323
N60250	13224.0	11530.4	0	9506	0	21600	0	0	4252	0	0	8950	0	0	0
N60251	8468.0	9370.0	336.	172878	183456	0	0	0	0	0	0	0	0	0	0
N60252	146716.8	0	0	0	0	0	0	0	0	0	0	0	0	0	0
N60253	24174.4	0	0	0	128582	0	0	0	0	0	0	0	0	0	0
N60254	74321.2	0	0	0	10440	2064	0	0	500	227457	0	0	0	944	2124
N60255	50587.6	32322.4	3000.	0	800	0	0	0	0	0	0	0	0	0	0
N60256	93305.6	111706.0	0	11330	0	0	0	0	0	0	0	0	0	0	0
N60257	211781.2	205273.6	1400.	0	0	0	0	0	0	16088	0	0	0	0	0
N60258	9776.8	0	0	0	0	0	0	0	0	0	0	0	0	0	0
N60259	18954.4	5011.2	18950.	0	0	0	0	0	0	0	0	0	0	0	0
N60260	268621.2	233334.0	-281859.	14541	11376	77124	0	0	552457	0	92650	679273	124133	711172	2665
N60261	143294.8	49021.6	0	72324	0	3602	0	2500	0	0	0	27480	0	0	0
N60262	18796.8	18418.4	0	4920	0	286	0	102792	0	0	0	87068	0	80	5568
N60263	226311.2	125239.	6207.	0	8832	16488	0	6784	0	623445	341768	167432	167432	82757	939
N60264	213496.0	207771.2	18500.	71850	11480	282989	96	543	61831	720	124891	135857	311694	311694	29733
N60265	494902.4	307771.2	0	2150	0	2361	0	0	4528	30108	99910	0	5880	2152	0
N60266	18216.8	32213.2	0	0	0	0	0	0	0	0	0	0	0	0	0

\*Conversion factor: 11.6 MBtu = 1 MWhr



Table A-1. Facility Square Footage Areas and Electrical Consumption (Continued)

DEIS		1975		Electrical Consumption												
II	UIC	Consumption [NBtu]*	Consumption [NBtu]	SQFTOT [ft <sup>2</sup> ]	SQFT1 [ft <sup>2</sup> ]	SQFT2 [ft <sup>2</sup> ]	SQFT3 [ft <sup>2</sup> ]	SQFT4 [ft <sup>2</sup> ]	SQFT5 [ft <sup>2</sup> ]	SQFT6 [ft <sup>2</sup> ]	SQFT7 [ft <sup>2</sup> ]	SQFT8 [ft <sup>2</sup> ]	SQFT9 [ft <sup>2</sup> ]	SQFT10 [ft <sup>2</sup> ]	SQFT11 [ft <sup>2</sup> ]	SQFT12 [ft <sup>2</sup> ]
M62798	M68095	30090.4	124711.6	0.	0	0	5000	0	8440	276400	0	0	0	0	3200	616
M68095	M68233	77024.0	21146.8	0.	36	103906	527488	150071	74062	5324	386087	256800	0	22356	1580	27442
M68233	M68094	407368.8	320090.4	805.	1320	9769	6207	0	0	0	0	0	2362	36946	31370	440
M68094	M68288	17608.8	22875.2	0.	0	0	6207	0	0	96	466975	0	0	20347	0	19787
M68288	M68020	149918.4	152772.0	0.	0	61796	12143	0	0	42700	67400	0	0	53955	28947	946
M68020	M68843	351712.0	252021.6	443000	149789	196622	714000	0	0	164007	0	0	0	336292	766021	531231
M68843	M67053	498985.6	389458.4	-4581	0	0	0	0	0	10080	0	0	0	597620	103393	882
M67053	M65534	19983.6	15871.6	0.	34942	2690	11565	0	0	3744	0	1779	4135	33911	19969	3473
M65534	M63680	40658.0	42828.4	100.	0	0	13814	0	0	0	0	0	2620	3538	24264	7768
M63680	M60182	84506.4	185810.4	35307.	0	0	0	0	272942	954	0	0	0	0	827	2073
M60182	M60478	51074.8	20532.0	0.	0	1596	169663	10992	16000	350010	0	0	93749	0	13304	9799
M60478	M65685	65853.2	86002.4	0.	41702	63508	20309	812	21373	61206	8098	0	12312	38013	48836	5313
M65685	M60921	145417.6	102381.6	52952.	214613.	0	294013	0	0	285268	0	0	68369	85726	150649	15328
M60921	M60018	614695.6	522997.6	214613.	0	3885	2051357	0	0	0	0	0	0	0	0	7802
M60018	M91285	19082.0	20334.8	1908.	67037	0	32623	0	1006673	4330	1440	0	130075	0	51230	7036
M91285	M60321	295985.6	313269.6	5024.	0	0	34843	0	2000	36282	0	0	0	0	0	0
M60321	M62271	14233.2	12702.0	24761.	0	0	0	560394	221592	1928975	0	15114	1200	0	1192	1852
M62271	M63290	398100.4	473222.0	25732.	148589	3236524	3236524	164149	1784	0	0	0	525762	0	211318	144017
M63290	M62640	1503696.4	1114040.8	101993.	36197	0	23696	0	0	2217	0	0	0	13114	6863	1771
M62640	M68086	215516.4	191922.0	-5446.	0	0	0	0	0	64	0	0	1909	0	4699	0
M68086	M61331	7238.4	4071.6	0.	0	0	11712	0	0	7149	0	0	0	133150	109695	8142
M61331	M61088	160555.6	129850.4	0.	500	645212	45009	0	816088	138743	6650	16142	215183	94850	109695	8142
M61088	M60246	280696.0	260327.2	69390.	19425	13445	473288	0	0	881	0	0	50264	184744	183248	42038
M60246	M67011	125477.2	103251.6	400.	0	340242	0	0	0	0	0	0	0	168774	36	273
M67011	M93055	6820.8	5498.4	3800.	4893	148895	0	0	0	0	0	0	0	0	892	580
M93055	M60701	3735.2	3062.4	0.	2793	0	0	0	0	0	0	0	0	0	0	0
M60701	M68311	160938.4	107729.2	16133.	1796	59266	37213	0	258445	26084	0	4481	136791	73795	54412	8582
M68311	M65886	501746.4	389818.0	0.	267748	208052	944493	0	0	555002	0	0	243352	620110	158132	7860
M65886	M62474	803358.0	691487.6	90923.	194658	452275	1384079	797	3038	938554	0	13022	657519	938823	649400	11969
M62474	M60701	8328.8	11147.6	7410.	0	0	0	0	0	0	0	0	0	0	0	0
M60701	M68311	964447.2	616398.0	173058.	8000	29972	28427	758972	415764	182325	0	0	82498	0	8906	1233
M68311	M65886	182639.2	134232.6	94945.	25813	24435	736403	136098	0	209068	0	9001	76381	57326	38358	16362
M65886	M62474	160335.2	191083.6	414.	0	136495	103445	0	0	1590	24648	24728	115584	312846	708484	2429
M62474		458002.8	400852.4	41924.	0	0	1381220	4000	0	0	0	0	35005	0	0	36
		27457.2	22226.6	4134.	0	47319	8610	0	0	0	0	0	196438	0	0	745

\*Conversion factor: 11.6 NBtu = 1 MW/hr

APPENDIX B  
FAMILY HOUSING SQUARE FOOTAGE AREAS  
AND ELECTRICAL CONSUMPTION

Table B-1. Family Housing Square Footage Areas  
and Electrical Consumption

DEIS II UIC	1983 Area [ft <sup>2</sup> ]	1983 Electrical Consumption [MBtu]	1975 Area [ft <sup>2</sup> ]	1975 Electrical Consumption [MBtu]
D00620	1761235	313420.4	1734276	359310.0
D00207	559103	67848.4	523000	63544.8
D00174	453304	29394.4	419648	29174.0
D57075	265068	27840.0	303823	32990.4
D68101	38094	1740.0	38094	1925.6
D63032	1209528	128064.0	1183612	65134.0
D63126	1367491	77963.6	1367491	89992.8
D65928	1424251	297447.2	1020869	204786.4
D00743	0	.0	198560	39741.6
D00129	3536518	298120.0	2932943	244620.8
D00178	321120	39115.2	271027	35751.2
D00216	1184505	164685.2	1170147	212303.2
D60200	467358	73184.4	127583	25682.4
D57041	0	.0	38186	5997.2
D57056	50682	10706.8	49966	12783.2
D60036	174014	12400.4	173544	11275.2
D00109	511110	67999.2	341755	44973.2
D62735	179745	9488.8	279863	30658.8
D00168	28066	1786.4	28000	2018.4
D00205	425607	61224.8	176000	28559.2
D60478	105455	6264.0	102203	6264.0
D00702	203892	20149.2	151572	10776.4
D68311	2295072	151217.6	2310773	134954.4
D62661	2827596	115918.8	2496431	124595.6
D62395	4480921	1065958.8	3989259	1156728.8
D00197	22233	2528.8	22282	2076.4
D68330	39708	8700.0	48708	3398.8
D00886	107963	4234.0	97108	4303.6
D00181	559363	64960.0	624588	54253.2
D62507	716443	65609.6	385446	56155.6
D57054	29925	1914.0	29125	2900.0
D66833	560094	88670.4	604847	104806.0
D60087	909963	114155.6	914145	114480.4
D57040	0	.0	37677	4883.6
D35328	36980	2714.4	36990	4628.4
D70310	64876	4883.6	44625	6090.0
D70278	100060	11054.8	99989	14233.2
D00104	180701	9871.6	176950	11066.4
D00421	1071049	122612.0	992129	96430.8
D63891	209730	34498.4	191390	40368.0
D68436	2209960	396882.4	579224	90201.6
D00788	43563	5278.0	43663	6159.6
D57049	37024	12249.6	37024	7308.0
D65114	1191353	109260.4	1221121	113888.8
D05344	88082	10266.0	87550	10869.2
D00389	1540523	340309.2	1383000	362047.6
D63042	2125231	400988.8	2125231	239087.6
D62585	109776	649.6	0	.0
D00164	98467	7319.6	96812	9639.6
D60201	1536651	318512.8	948365	204809.6
D62863	1113849	21831.2	1118848	696.0
D60508	677138	65192.0	673584	73010.4
D66818	46004	3897.6	42275	3642.4
D62741	85753	7052.8	85753	9639.6
D61174	1024081	50692.0	1021283	50158.4
D00296	590273	45796.8	621018	43836.4
D62271	1270004	81234.8	1235025	73451.2
D60462	1066078	.0	899685	.0
D00102	440660	31958.0	269861	26030.4
D57055	41811	7180.4	41811	8711.6
D62995	171917	18560.0	171917	23130.4
D00025	0	.0	2171000	122530.8
D68335	343016	61097.2	343000	36888.0
D00187	4708978	599592.4	3468373	362569.6

Table B-1. Family Housing Square Footage Areas  
and Electrical Consumption (Continued)

DEIS II UIC	1983 Area [ft <sup>2</sup> ]	1983 Electrical Consumption [MBtu]	1975 Area [ft <sup>2</sup> ]	1975 Electrical Consumption [MBtu]
D00161	996106	78520.4	996106	55320.4
D62269	363206	36876.4	338000	31436.0
D00396	13953	1160.0	13953	997.6
D61414	1563382	196515.6	1507699	189033.6
D57053	80716	3584.4	37800	1774.8
D00383	35768	7424.0	36408	6484.4
D63038	88291	6658.4	63566	3572.8
D60514	1381927	.0	1401321	.0
D60042	224960	23072.4	310914	38326.4
D62604	182411	29255.2	8797	626.4
D42237	455984	40066.4	0	.0
D32960	30470	13827.2	5400	429.2
D00215	19130	2122.8	18600	2714.4
D63427	246673	43302.8	260115	40379.6
D00153	9783	696.0	0	.0
D65113	3358577	237092.4	2933494	203649.6
D60376	490165	84053.6	501584	81664.0
D00221	1251121	61700.4	1406741	75782.8
D00171	606944	67999.2	651701	94029.6
D63395	114181	25891.2	44800	8874.0
D60495	374941	23084.0	344895	19766.4
D00255	365877	53209.2	362624	69263.6
D61331	87635	16541.6	87635	16216.8
D00213	2668474	370770.8	2057822	532184.8
D68378	4849004	305474.4	4784144	387440.0
D00639	1328549	175948.8	1245221	145290.0
D00158	19759	2911.6	19759	788.8
D00173	36586	3619.2	41866	1589.2
D62285	16987	.0	14467	.0
D00193	3788098	459255.6	2712811	369529.6
D63073	286429	46910.4	198732	10672.0
D63387	8901161	572042.4	6099000	434756.4
D66754	205414	44752.8	203814	59624.0
D00275	74679	4164.4	164000	6913.6
D62808	2473765	330565.2	2164262	420766.8
D60530	1460925	135186.4	2980785	213057.2
D61533	28602	2064.8	0	.0
D0417A	0	4118.0	0	3886.0
D60701	18663	649.6	18663	1090.4
D32778	75452	3909.2	75452	5417.2
D65115	2485237	267542.4	2518170	278864.0
D00151	1591117	150104.0	1006438	93298.8
D00281	43155	6588.8	43155	8456.4
D00206	305604	46052.0	14000	1995.2
D63043	697933	84703.2	446071	57153.2
D00196	14382	1310.8	14382	1948.8
D62578	25827	1206.4	200000	8990.0
D65995	86474	23640.8	0	.0
D60259	120330	5115.6	122847	12249.6
D60241	302291	43766.8	304978	54021.2
D61337	67548	9500.4	79478	8062.0
D62583	979168	46098.4	774152	42931.6
D68349	51458	6751.2	76238	8665.2
D62588	546205	48464.8	183088	16193.6
D62755	9188808	1235806.0	8565358	1313560.8
D00101	387343	24313.6	432913	22318.4
D60191	1464464	123412.4	1469873	127808.8
D62481	521575	12330.8	199127	.0

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